

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1



IN THE UNITED STATES

PATENT AND TRADEMARK OFFICE

Applicant: MUKHOPADHYAY, Debasish)
Serial No.: 09/243,237)
Filed: 02/02/99)
Title: HIGH PURITY WATER PRODUCED)
BY REVERSE OSMOSIS)
Art Unit: 1723)
Examiner: Fortuna, A.)

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INFORMATION DISCLOSURE STATEMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

The following sections are being submitted for this
Information Disclosure Statement:

1. Preliminary Statements
2. Identification Of Time of Filing
3. Statements With Respect to Listing of Information
4. Identification of Prior Application in Which Listed
Information Was Already Cited and For Which No Copies
Are Submitted or Need to be Submitted.
5. Statements With Respect To Copies Of Listed Information
Items Accompanying This Statement
6. Concise Explanation of Listed Information Items
7. Translation of Non-English Language Documents
8. Identification of Person Making This INFORMATION
DISCLOSURE STATEMENT.

A return receipt postcard is also enclosed.

CERTIFICATE OF MAILING

I hereby certify that this Information Disclosure Statement (along with any paper referred
to as being attached or enclosed) is being deposited with the United States Postal Service
on the date shown below with sufficient postage as Express Mail Post Office to Addressee,
mailing label No.: EK686752394US in an envelope addressed to:
Assistant Commissioner For Patents, Washington, D.C. 20231.

Rhonda Goodloe
Rhonda Goodloe

Date: April 6, 2000

1. Preliminary Statements

Applicant submits herewith a listing of patents and other art of which he is aware which he believes may possibly be material to the examination of this application and in respect of which there may be a duty to disclose in accordance with 37 CFR § 1.56.

The filing of this information disclosure statement shall not be construed as an admission that the information cited is, or is considered to be, material to patentability, or an assertion that no other material information exists.

The filing of this information disclosure statement shall not be construed as an admission against interest in any manner. Notice of January 9, 1992, 1135 O.G. 13-25, at 25.

2. Time of Filing

This Information Disclosure Statement is filed before the mailing date of a final office action or notice of allowance. (37 CFR § 1.97(c)(2)).

3. Statements With Respect To Listing of Information

A list of the patent(s) and/or publication(s) is set forth on the attached page of Form PTO-1449 (Modified).

A copy of the International Search Report in the companion PCT case - International Application No.:PCT/US97/14239, International Filing Date of August 12, 1997, is attached.

4. Identification of Prior Application in Which listed Information Was Already Cited and for Which No Copies are Submitted or Need to be Submitted.

This application relies, under 35 U.S.C. § 121, on the earlier filing date of prior application Serial No. 08/909,861 filed August 12, 1997. The references not marked with an asterisk "*" were submitted to, and/or cited by, the Patent Office in the prior application(s) and, therefore, are not required to be attached to the

Information Disclosure Statement for this application, in accord with 37 C.F.R. 1.98 (d).

5. Statements With Respect To Copies of Listed Information Items Accompanying This Statement

Legible copies of all items listed in Form PTO 1449 accompany this information statement except items in the prior applications, from which an earlier filing date is claimed for this application, as discussed in Section 4 above. The items marked with an "*" were not submitted to, and/or cited by, the Patent Office in the prior application(s) and, therefore are required to be attached to the Information Disclosure Statement for this application, which items are supplied herewith.

6. Concise Explanation of Listed Information Items

A concise explanation of the items listed on PTO-1449 (Modified) is given for each listed item.

U.S. PATENTS

| <u>Patent No.</u> | <u>Inventor/ Issued</u> | <u>Explanation</u> |
|-------------------|-----------------------------|---|
| 3,721,621 | Hough 03/20/73 | Uses pH adjustment to adjust solubility of a solute in water prior to membrane separation. Generally, see col. 3 and col. 4, and claim 1. |
| 3,870,033 | Faylor, et al 03/11/75 | Describes process for producing 18 meg-ohm water for semi-conductor manufacturing. See Fig. 1 and col. 5, line 67 to col. 6, line 8, where flow path 32a is described to incorporate a softener before an RO unit, and a degasifier <u>after</u> the RO unit. |

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

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| 3,953,580 | Allen, et al 04/27/76 | States that in RO systems, an increase in boron rejection occurs with an increase in pH. See col. 1, lines 43-51. Allen concludes that borate ion is rejected by the RO membrane, so he teaches that boric acid production is assisted by utilizing membranes having low boron rejection, and operating a suitable pH, so that the desired boron is preferentially transported with the clean permeate, rather than rejected (as desired in water purification). |
| 3,964,999 | Chisdes 06/22/76 | Discloses hardness removal before an RO system. See Fig. 1. |
| 3,985,648 | Casolo 10/12/76 | Discloses multi-bed ion exchange system, including a weak acid cation exchange resin in the hydrogen form, for purifying mineral contaminated water. See Fig. 1 and claim 1. |
| 4,182,676 | Casolo 01/08/80 | Discloses multi-bed ion exchange system, including weak acid cation exchange resin in hydrogen form, to capture selected contaminants at optimum pH ranges. See col. 4, lines 12-27 and claim 1. |

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

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| 4,235,715 | Wiegert 11/25/80 | Discloses removal of hardness and alkalinity in boiler feedwater by (a) use of weak acid cation resin in the hydrogen form, (b) degasification, and (c) followed by weak acid cation resin in the sodium form. See Fig. 2 and col. 2, line 15 through col. 3, line 3. |
| 4,321,145 | Carlson 03/23/82 | Discloses use of ion exchange to remove cyanide values from water, and recovery of cyanide salt liquor by treating the ion-exchange rinse streams with caustic solution. See col. 1, lines 54-59. |
| 4,430,226 | Hegde, et al 02/07/84 | Discloses production of 18 meg-ohm water by pretreating a feed stream in an admixture of mixed-ion exchange resin and activated carbon, before RO treatment. See col. 2, lines 1-16. |
| 4,532,045 | Littman 07/30/85 | In a cooling tower circulating water system, teaches removal of hardness and bicarbonate values with a weak acid cation exchange system, removal of suspended solids, and adding scale inhibitors, to minimize blow-down rates from the circulating system. See col. 4, lines 30-68. |

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

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| 4,532,047 | Dubin 07/30/85 | Generally describes various efforts to control silica scale in conventional water treatment systems, and additives useful for controlling such scale. Table I describes amorphous silica solubility vs. pH. |
| 4,548,716 | Boeve 10/22/85 | Describes production of bacteria and pyrogen free, ultra-pure water, by deionizing the water (using RO, ion-exchange) and purifying the water (UV, and ozone). See col. 3, lines 3-26, and claim 12. |
| 4,574,049 | Pittner 03/04/86 | Describes injection of a solution having a pH in excess of 7 to the "second stage" of a reverse osmosis system (more conventionally, "second pass" since the second unit treats permeate from the first unit) to ionize certain otherwise difficult to ionize components to increase their rejection in the RO system. See col. 4, lines 5-48. Pittner removes hardness by an ion-exchange resin type softener, but does not include degasification or alkalinity removal prior to starting RO processing of the feedwater. |
| 4,698,153 | Matsuzaki, et al 10/06/87 | Shows production of ultrapure water via RO and ion-exchange. Feed to an RO unit is filtered, and permeate is degassed and sent to ion-exchange. See Fig. 3 and claim 8. |

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

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| 4,755,298 | Grinstead 07/05/88 | Describes removal of boron ion from aqueous brines via use of a water soluble organic chelant, preferably at pH between about 5 and 9, and then releasing the boron by contacting the chelant with a mineral acid, then recovering the chelant. See col. 11, line 34 through col. 2, line 11. |
| 4,820,421 | Auerswald 04/11/89 | Describes process of demineralizing power plant feedwater by using a series of at least three ion exchange resin treatment zones, including strong acid cation (SAC), anion resin, and weak acid cation (WAC) treatment. For general information, see col. 5, line 50 through col. 6, line 44. |
| 4,824,574 | Cadotte, et al 04/25/89 | Describes flux rates, problems of membrane plugging, and rejection enhancement, in RO systems, where the membrane is used for hardness removal. See col. 1., lines 40-50 regarding membrane flux ("...flux of at least 10, preferably at least about 15 gallons per square foot per day... would be desirable."). Also, see claim 2 regarding a membrane with a flux of "at least 15 gpd". |

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

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| 4,900,450 | Schmidt 02/13/90 | Describes the use of a weak acid cation (WAC) resin bed to remove residual alkalinity from water after it passes through a strong acid cation resin bed. See col. 2, lines 10-24, regarding use of WAC at near neutral pH conditions. |
| 4,917,806 | Matsunaga, et al 04/17/90 | Describes the adjustment of pH of water, by control of water flow rate through a pair of ion exchange beds, to control the pH of the mixed outlet stream from the ion exchange units. See col. 2, line 40 through col. 3, line 4. |
| 4,969,520 | Jan, et al 11/13/90 | Describes co-precipitation of silica with magnesium hydroxide after mixing caustic with feedwater containing calcium and magnesium, and removal of residual hardness by WAC type ion-exchange resins. See (a) FIG. 1, (b) col. 1, line 53 through col. 2, line 3, and (c) col. 6, lines 38-56. |
| 4,995,983 | Eadie, et al 02/26/91 | Describes recovery of peroxide from alkaline wastewater of pulp bleaching process in a reverse osmosis system. The fraction of peroxide in ionized form, and thus the recovery of peroxide, is increased by adjustment of pH to at least 11.5. See col. 4, lines 27-58. |

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

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| 5,028,336 | Bartels, et al 07/02/91 | Describes processing of oil production "produced waste waters" by nanofiltration at increased pH's, preferably 7-9, "say about 8.5," to remove water soluble organic electrolytes. See col. 11, line 20 through col. 12, line 2, and col. 15, lines 32-40. |
| 5,061,374 | Lewis 10/29/91 | Describes a two train ultrapure water production system for manufacture of 18 meg-ohm water, via treatment through a mixed bed ion exchange unit, a UV sterilizer, an RO unit, and a filter. See col. 2, lines 23-44, and claim 1. |
| 5,073,268 | Saito, et al 12/17/91 | Discloses process for manufacture of ultrapure (18 meg-ohm) water. The process includes the use of a UV/hydrogen irradiation unit followed by a mixed bed ion exchange polisher, before entry into a RO unit. See Table 2 for actual results achieved by the process; Table 1 indicates industry quality standards. Use of mixed bed type ion exchange resins with H+ type strongly acidic cation exchange resin, and OH-type strongly basic anion exchange resin, results in no pH change to the feedwater stream after treatment, since the eluted ions combine to form water. See col. 6, lines 10-21. |
| 5,174,901 | Smith 12/29/92 | Shows use of sand filter, carbon filter, and water softener prior to an RO unit. See Fig. 1. |

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

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| 5,236,722 | Schroeder | Describes process of removing hardness to less than 2 grains prior to reverse osmosis, and removing organic and inorganic matter in an RO unit. See col. 1, line 66 through col. 2, line 9. |
| | 08/17/93 | |
| 5,246,586 | Ban, et al | Describes a "2B3T" (two bed, three tower) type system for pre-treatment of a feedwater to a reverse osmosis unit engaged in production of ultrapure water. A cation exchange resin tower, a decarbonation tower, and an anion exchange resin tower are serially connected for treatment of feedwater. The pH is adjusted by introducing acid or alkali prior to feed to the cation exchange resin tower, or elsewhere. See (a) col. 5, line 57 through col. 6, line 2, (b) Fig. 3, and (c) claim 1. |
| | 09/21/93 | |

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

5,250,185

Tao, et al

10/05/93

Describes processing of oilfield produced waters containing boron and water soluble organic electrolytes. Hardness removal is followed by raising the pH to above about 9.5, before processing the charge liquid in a reverse osmosis unit. See col. 4, line 46, through col. 6, line 4. Although it is inherent in Tao's process that alkalinity associated with temporary hardness is removed (calcium bicarbonate and magnesium bicarbonate), the process does not remove the alkalinity not associated with hardness (mainly, sodium bicarbonate). As a result the Tao process does not need or use a degasifier, and is also forced to use anti-scalant, to prevent precipitation of calcium carbonate. Tao's process fails to remove the bulk of the alkalinity before charge of feedwater to the reverse osmosis unit, as taught by the claimed invention herein.

Also, Tao's process uses lime softening primarily to remove silica (see col. 7, lines 17-28), to keep the reverse osmosis unit from fouling with silica. In contrast, the present invention does not require a silica removal pretreatment step, as the pH is raised to insure high silica solubility.

Additionally, Tao recommends the use of anti-scalant, whereas the present invention avoids the necessity to use scale inhibitor. See Tao, 11col. 4, line 57 through col. 5, line 2.

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

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| 5,266,203 | Mukhopadhyay, et al | Describes removal of cyanide compounds from an aqueous waste stream, as well as heavy metals and precious metal values, by raising the pH with carbon dioxide, up to about 8 to about 10, and preferably between 8.5 to 9.5, before processing the aqueous waste stream through a membrane separation system. See col. 3, line 55 through col. 4, line 11, regarding membrane rejectable cyanide compounds. |
| | 11/30/93 | |
| 5,292,439 | Morita, et al, | Discloses a method for making ultrapure water in an ion exchange resin with a total organic carbon content of 3 ppb. See col. 7, line 24 through col. 8, line 14, for a description of the ultrapure water treatment train. |
| | 03/08/94 | |

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

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| 5,338,456 | Stivers | Describes pretreatment for an RO system which includes (1) acid addition, (2) degasification, and (3) base addition. First, pH is reduced "to about 4.4", and then, after vacuum degasification, the pH of the feedwater is raised "up to about 6.5" before it is fed to the RO unit. Generally, see col. 5, line s12-43, and col. 6, lines 37-54, which also mentions that it was "conventional in the art" to locate the degasification area downstream of the RO unit, rather than upstream. |
| | 08/16/94 | The Stivers system also requires "antiscalant to prohibit crystal growth." See col. 3, lines 65-69. |
| 5,358,640 | Zeihner, et al | Describes technique for controlling calcium sulfate scaling in reverse osmosis equipment by controlling the pH to between about 6 and 7 and adding scale inhibitor and/or iron dispersants to the feedwater. See col. 2, line 60 through col. 3, line 2. |
| | 10/25/94 | |
| 5,385,664 | Oinuma, et al | Describes an ultrapure water production apparatus that includes the use of biological treatment, UF or MF, and demineralization, prior to RO, and post RO treatment including UV, mixed bed ion exchange, and UF. See Fig. 1B. TOC is reduced to 0.5 to 0.8 ppb. See col. 5, Example 1, and claim 7. |
| | 01/31/95 | |

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

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| 5,476,591 | Green 12/19/95 | Describes recovery of metal values from an aqueous charge stream, by using a nanofiltration system. Downward adjustment of pH of less than about 3.5, to keep ions in solution, is utilized. See col. 4, lines 63 through col. 5, line 12. Also, anti-scalant use is preferred when the product contains substantial amounts of calcium ions. See col. 25, lines 16-67. |
| 5,529,689 | Korin 06/26/96 | Shows two stage water purifier. Not believed particularly relevant. |
| 5,571,419 | Obata, et al 11/05/96 | Describes production of low TOC ultrapure water. Feedwater is pretreated via addition of reducing agent, cation ion exchange resin, anion ion exchange resin, decarbonation tower, cation ion exchange resin, and anion ion exchange resin. Then, the water is processed in a reverse osmosis unit. That is followed by UV, demineralization, and UF. TOC achieved ranges from 0.5 to 1.0 ppb. See Fig. 2, Example 1, and Table 1. |
| 5,573,666 | Korin 11/12/96 | Shows two stage water purifier. Not believed particularly relevant. |

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

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| 5,670,053 | Collentro, et al | Describes a process of removing cations, anions, and carbon dioxide from feedwater to produce high purity water having a resistivity greater than 1 meg-ohm-cm. This disclosure teaches operation of the RO in the pH range of 5 to 8, and typically 5.5 to 7.5. Permeate from the first RO unit is introduced into a gas-liquid separation module which includes a gas operation membrane through which carbon dioxide passes. See Fig. 1, claim 1, and the Abstract. |
| | 09/27/97 | |
| 5,695,643 | Brandt, et al | Discloses treatment of oil field brines by combination of membrane and thermal treatment. See col. 5, lines 1-53 regarding pretreatment to the RO system, which includes filtering and softening. |
| | 12/09/97 | |

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

5,766,479

Collentro
et al

06/16/98

Describes process for producing pure water with resistivity of from 2 to 10 meg-ohm-cm, for pharmaceutical uses. Feedwater pH is adjusted to a basic solution, and the basic solution is feed to a first RO. Then, the permeate pH is adjusted to an acidic solution, which is fed to a second RO. In each case, ionization occurs of weakly ionized material, to enhance rejection at the respective pH of operation. See Fig. 1, and the abstract.

Collentro's process does not teach or suggest the positive removal of alkalinity prior to initiating membrane separation. Also, the process requires two pass reverse osmosis operation, with inter-pass pH adjustment; this differential pH operation compromises the ability to return liquid to the first RO unit.

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

FOREIGN PATENTS

| <u>Patent Disclosure (Disclosure Date)</u> | <u>Country</u> | <u>Explanation</u> |
|--|----------------|--|
| DE 1792304 03/30/72 | Germany | Evidently deals with phosphate removal. (No English abstract available; English translation not available to undersigned). |
| 50-75987 06/21/75 | Japan | Shows 2-pass RO system. (No English abstract available; English translation not available to undersigned). |
| 50-88017 07/15/75 | Japan | Discloses raising pH to 5 or higher for removal, in reverse osmosis equipment , of organic acids from stream containing organic acids and ammonia. Upper limit of pH of about 8.5 for acetyl cellulose membranes and about 11 for polyamide membranes is disclosed. |
| DE 2607 7376 A1 09/02/76) | Germany | Shows 2-pass RO system. (English abstract only; English translation not available). |
| 53/4777 01/17/78 | Japan | Shows 2-pass RO system. (English abstract only; English translation not available). |
| 54/83688 07/03/79 | Japan | Shows 2-pass RO system. (English abstract only; English translation not available). |

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

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| 54/69579 04/06/79 | Japan | Describes 2-pass RO system with addition of acid or alkali between the first and second RO units. (English abstract only; English translation not available). |
| 56/139106 10/30/81 | Japan | Describes pH dependency of certain in RO rejection, including boric acid. (English abstract only; English translation not available). |
| 58/118538 07/15/83 | Japan | Describes 2-pass RO system with addition of alkali between the first and second RO units. (English abstract only; English translation not available). |
| 58/122084 07/20/83 | Japan | Describes 2-pass RO system for seawater desalting. (English abstract only; English translation not available). |
| Sho 59-112890 06/29/84 | Japan | Discloses addition of alkali to RO feedwater stream, to adjust pH to 8 or higher, and preferably over 9, prevent precipitation of silica on membrane surfaces. |
| Sho 62-204892 09/09/87 | Japan | Discloses lowering pH of feedwater by hydrogen form cation exchanger to prevent bacteria propagation, followed by reverse osmosis treatment. |
| Hei 2-207888 08/17/90 | Japan | Discloses method for produced ultra-pure water by enhancing TOC removal by pH adjustment downward. |

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

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| 2-227185 09/10/90 | Japan | Discloses method for treating water containing silica, by dealkalinating and softened by treating it in a weakly-acidic cation exchange resin, and subsequently raising the pH to make the RO feedwater neutral or slightly alkaline. |
| *Hei 6-49191 06/29/94 | Japan | Teaches reduction of carbonates to reduce calcium carbonate scaling in an RO system. |
| DE 196 03 494.9-41 08/07/97 | Germany | Shows use of a cation exchanger prior to RO. (English translation provided) |

OTHER DOCUMENTS

| <u>Authors; Title</u> | <u>Date/ Volume Pages</u> | <u>Explanation</u> |
|---|-----------------------------------|---|
| Milstead, C.E., et al <u>Rejection of Carbon Dioxide and pH Effects in Reverse Osmosis Desalination</u> Desalination | 1971 pp. 217- 223 | Generally describes behavior of carbon dioxide in RO units See p. 222, 1st paragraph under "Discussion". |
| Petersen, R.J., et al <u>Industrial Applications of the FT-30 Reverse Osmosis Membrane</u> World Filtration Congress III (1989) pp. 541-547 | 1989 pp. 541- 547 | General information on FT-30 membranes. See p. 543 on sodium borate rejection. |

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

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| <p>Larson, R.E. et al <u>Development of the FT-30 Thin-Film Composite Membrane</u> National Water Supply Improvement Association 9th Annual Conference and International Trade Fair</p> | <p>May 31-June 4, 1981</p> | <p>Describes use of FilmTec FT-30 membranes in various applications. See various flux projections; see p. 20 regarding operation at high pH in plating solutions.</p> |
| <p>Lee, Eric K.L. <u>Novel Composite Membranes</u></p> | <p>April 1983</p> | <p>Describes development of composite membranes. Not believed particularly relevant.</p> |
| <p>Crabbe, Daniel C.M. <u>A Double Pass Reverse Osmosis System</u></p> | <p>September 1976</p> | <p>Describes use of 2 pass RO. Indicates higher carbonate rejection at pH in excess of 7.5.</p> |
| <p>Nakamura, Tadashi <u>Seawater Desalination by Reverse Osmosis Process</u></p> | <p>July /August 1981</p> | <p>Describes use of RO for seawater desalination. Note scaling problems described 2nd col., p. 39.</p> |
| <p>Cadotte, J. <u>Evolution of Composite Reverse Osmosis Membranes</u></p> | <p>1984</p> | <p>Describes FT-30 membranes. Note p. 290 where pH of 3-11 is recommended.</p> |
| <p><u>1982 Report on Technological Development For Boiler Water by Reverse Osmosis</u>, Exhibit Ko No. 1, Fresh Water Generation Promotion Center</p> | <p>March, 1983 pp. 1-11, 45-97</p> | <p>Describes various testing on RO membranes. Note relationship of bacteria population to pH of water.</p> |
| <p>Ed. Walter Lorch <u>Handbook of Water Purification</u> London MacGraw-Hill Cop.</p> | <p>1981 XVIII, 715 p. III</p> | <p>Describes customary RO pretreatment with acid to keep pH low, with later carbon dioxide removal.</p> |

INFORMATION DISCLOSURE STATEMENT
Attorney Docket No. MDO-2471-U-D1

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| E.I. du Pont de Nemours & Co. <u>Permasep Products Engineering Manual</u> | 1982 | General membrane information. See borate rejection curve Fig. 5 for B-9 permeators, in Bulletin 305, page 6. See Fig. 2, Bulletin 502, p. 3, regarding bicarbonate passage. See Fig. 11, Bulletin 502, page 15, regarding silica solubility. |
| Edited by Bipin S. Parekh <u>Applications for High-Purity-Water Production</u> | 1988 | General background information. See p. 63-65 regarding rejection and flux definitions. |
| <u>Development of FT-30 Membranes In Spiral Wound Modules</u> | October 1982 | General information on FT membranes. See Fig. 5 and note Fig. 14, regarding flux decline over time. |
| Crabbe, Daniel C.M. <u>A Double Pass Reverse Osmosis System</u> Industrial Water Engineering. | December 76 January 77 | Describes a 2-pass RO system. See p. 14 regarding rejection of carbonate at pH greater than 7.5. |
| <u>Handbook of Membrane Technology</u> | July 15, 1985 pp. 184-198 | Shows use of RO in production of municipal water. (In Japanese language. No English translation available). |
| <u>Annual Research Report No. 42,</u> Shikoku Electric Power Co., Ltd. | September 1983 | Shows use of typical 2B3T system prior to RO. Multiple pass operation indicated. (In Japanese language. No English translation available). |

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-D1

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| <u>Zosui Gijutsu</u> <u>Water Producing</u> <u>Technology</u> | 1984 Vol. 10, No. 2, pp. 13-22 | Shows double pass RO with initial feed at low pH (English language abstract only. In Japanese language. No translation available). |
| <u>FT30 Membrane</u> <u>Description</u> Technical Bulletin | December 1992 | Indicates that continuous operation from pH 3 to 11 is possible. |
| <u>Description of the FT-30 Membrane</u> | | Same as reference above. Indicates operation possible up to pH 11. |
| Peterson, R.J., et al <u>Development of the FT-30 Thin-Film Composite Membrane For Desalting Applications</u> | July 6-10, 1980 | See p. 11; indicates operation up to pH 11 o.k. |
| <u>Reverse Osmosis</u> <u>Element Warranty</u> Filmtec Corporation | | Not believed particularly relevant. |
| Larson, R.E. <u>The FT-30 Seawater</u> <u>Reverse Osmosis</u> <u>Membrane - Element</u> <u>Test Results</u> Desalination 38 | 1981 p. 473-483 | See Figs. 5 and 6. Note long term flux below 20 gfd. |
| <u>Handbook of Membrane</u> <u>Technology</u> | July 15, 1983 p. 26-28 | Shows relationship of carbon dioxide to pH of feedwater. (No English abstract. In Japanese language, no English translation). |
| Parks, C.S. et al <u>Fundamentals of Ion</u> <u>Exchange In Water</u> <u>Treatment</u> Presented at the 7th Annual Liberty Bell Corrosion Conference | | Describes fundamentals of ion exchange in water treatment. |

Dyke, F.T., et al
Removal of Salt, Oil
and Boron From Oil
Field Wastewater by
High pH Reverse
Osmosis Processing

September,
1992

Describes in more detail the process set forth in the Tao patent, U.S. 5,250,185. Reveals that in spite of using a "high rejection" version of a FilmTec Sea Water membrane, SiO₂ rejection in Tao's process was only 39%. In the present invention, SiO₂ removal was 99.87%. So, this paper shows that the SiO₂ passage in the Tao process was 61%. This is in marked contrast to the much less than 1% SiO₂ passage (actually, 0.13% SiO₂ passage) achieved in the instant invention, in spite of the use of a FilmTec brackish water membrane that has "minimum salt rejection" 2.5 times worse than the seawater type RO membrane used by Tao. Also, with respect to TOC, an important parameter in ultrapure water, passage was 0.80% in the Tao process, while in the instant invention it was 0.34%. So, Tao's TOC rejection was worse, even when using a better membrane, by about 5.9 times, on a performance equalized basis. See Table 2 of this paper, and compare to Table 4 in the pending application. Note membrane performance decay shown in Fig. 7 of this paper, and compare to Figs. 5, 6, 7, and 8 of the present application.

INFORMATION DISCLOSURE STATEMENT

Attorney Docket No. MDO-2471-U-DI

| | | |
|---|------------------|---|
| Tao, F.T. et al <u>Conversion of Oilfield Produced Water Into an Irrigation/Drinking Quality Water</u> | March, 1993 | Describes removal of boron and water soluble organics from oilfield produced water via hardness removal followed by reverse osmosis at a pH of 10.6 - 11.0. Note membrane performance decay shown in FIG. 4; compare to FIGS. 5, 6, 7, 8 of this application. |
| Aronovitch, H. et al <u>Weakly Acidic Cation Performance Treating Water Containing High Iron</u> | May/June 1995 | Describes the efficient performance of a weakly acidic cation resin in removing hardness associated with alkalinity. |
| Auerswald, D. <u>Optimizing the Performance of Reverse Osmosis/Continuous Electrodeionization System</u> | May/June 1996 | Describes methods of operation used to minimize cleaning of conventional RO systems. |

7. Translation of Non-English Language Documents

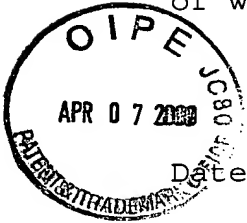
German: An English translation for the German patent DE 196 03 494 C2 was provided to, and/or cited by, the Patent Office in the prior application(s) and, therefore, is not required to be provided in the Information Disclosure Statement for this application, in accord with 37 C.F.R. 1.98 (d).

Japanese: Copies of the Abstracts to certain Japanese patents were submitted to, and/or cited by, the Patent Office in the prior application(s) and, therefore, are not required to be provided in the Information Disclosure Statement for this application, in accord with 37 C.F.R. 1.98 (d).

English translations of other Japanese patents or publications are currently not available, and are not in the possession, custody, or control of the applicant or the undersigned.

8. Identification of Person(s) Making This INFORMATION DISCLOSURE STATEMENT

The person making this statement is the attorney who signs below on the basis of the information supplied by the inventor and information in possession of the attorney, both of which have been reviewed by the attorney.



Date: April 6, 2000

Phone: 253-859-9128

Fax: 253-859-8915

Respectfully submitted,



SIGNATURE OF ATTORNEY

R. Reams Goodloe, Jr.
Reg. No. 32,466
Suite 3
10725 - S.E. 256th Street
Kent, Washington
98031-6426